xxvii. p. 171, that Huc's "tree of ten thousand images" is nothing more than a common white lilac. Myths of this kind I have generally found to have some substratum of fact at the bottom. They can be rationalised, and mere explosion does not seem to be a satisfactory way of getting rid of them.

Now our knowledge of the indigenous vegetation of China is painfully limited. An immense portion of the flora is doubtless gone beyond recovery in the cultivated districts. Remnants of the primitive, wide-spreading forest remain, however, in the precincts of temples and monasteries, and these woods have always yielded novelties to botanists who have examined them. It had seemed, therefore, little short of certain that the sacred tree of Kum-bum would be something of considerable scientific interest if specimens of it could be got hold of.

The only edition of Huc at hand to refer to is Hazlitt's translation, published by Thomas Nelson and Sons in 1856. The well-known account of the tree will be found on pp. 324-6. According to Huc, the name Kum-bum, or as he spells it, Koun-boum, consists of "two Thibetan words signifying ten thousand images, and having allusion to the tree which, according to the legend, sprang from Tsong-Kaba's hair, and bears a Thibetan character on each of its leaves." Now, according to Kreitner, as quoted by Mr. Keane, "the Abbé Huc tells us that its leaves bear the natural impress of Buddha's likeness and of the Thibetan alphabet." As a matter of fact, he does not say anything like this. What he does say is as follows:—

"There were upon each of the leaves well-formed Thibetan characters, all of a green colour, some darker, some lighter than the leaf itself. Our first impression was a suspicion of fraud on the part of the Lamas, but, after a minute examination of every detail, we could not discover the least deception. The characters all appeared to us portions of the leaf itself, equally with its veins and nerves; the position was not the same in all; in one leaf they would be at the top of the leaf, in another in the middle, in a third at the base, or at the side; the younger leaves represented the characters only in a partial state of formation. The bark of the tree and its branches, which resemble that of the plane-tree, are also covered with these characters. When you remove a piece of old bark, the young bark under it exhibits the individual outlines of characters in a germinating state, and, what is very singular, these new characters are not unfrequently different from those which they replace."

Of the tree itself as Huc saw it some forty years ago, he gives the following account:—

"The tree of the Ten Thousand Images seemed to us of great age. Its trunk, which three men could scarcely embrace with outstretched arms, is not more than eight feet high; the branches, instead of shooting up, spread out in the shape of a plume of feathers, and are extremely bushy; few of them are dead. The leaves are always green, and the wood, which is of a reddish tint, has an exquisite odour, something like that of cinnamon. The Lamas informed us that in summer, towards the eighth moon, the tree produces huge red flowers of an extremely beautiful character."

Hazlitt's translation contains two woodcuts, one (p. 325) of the tree with its canopy, the other (p. 369) of a leaf with its markings. What the history of these illustrations is, there is nothing to show; Huc's book in the original French had, I think, none. The leaf with its markings has a by no means impossible appearance; whether the markings are like Thibetan characters, I cannot say. The outline of the leaf is not unlike that of a fuchsia, but it would not pass for a lilac.

I suspect, then, that there really was in Huc's time a tree with markings on the leaves, which the imagination of the pious assimilated to Thibetan characters. Perhaps it was the last local relic of some unknown endemic tree; in Hongkong I believe many of the endemic species are represented by but a few individuals. It may well have died and been replaced by a lilac, and the genuine markings by the fudged-up image of Budha "etched with some acid on the leaves."

It is disappointing that Szechenyi's expedition seems to have done nothing for botany. As Grisebach says, "We can only guess at the richness of the Chinese flora." Every now and then some one is induced to collect a few plants, and almost invariably they contain something new to science. A more extended knowledge of Chinese plants is now essential to a right understanding of the phyto-geographical facts of the north temperate flora. Unfortunately, the numerous Europeans who visit China are occupied with political, religious, or commercial business, with little time for subsidiary pursuits. But any of them who may chance to read these lines, may rest assured that they will be really doing a useful work by collecting and drying even a few *wild* plants in their respective neighbourhoods.

Kew W. T. THISELTON DYER

NORWEGIAN GEODETICAL OPERATIONS[1]

IN 1861 an Association was formed, under the auspices of Lieut.-General von Baeyer, having for its object the measurement of arcs of meridians, and parallels, in Europe. Most of the Continental nations joined this Association, and have carried out triangulations and spirit levellings of precision to further the objects in view. It is the intention of the Association to measure an arc extending from Palermo to Levanger in Norway, which will, however, probably be extended to the North Cape. The work before us is the report of the measurement of two base lines, and of their connection with the Norwegian triangulation which is to form part of the measurement of the above-mentioned arc. It was thought in 1862 that the existing Norwegian triangulation, supplemented and verified by some new work, would meet the requirements of the Association; but it was found, on investigation, that such was not the case, and moreover that the verifications could not be carried out, because the old trigonometrical stations could not be refound with any certainty. It was therefore decided to commence a new triangulation extending in a chain from the Swedish frontier (south of Christiana), where the chain is connected with the Swedish triangulation, to Levanger, where again a connection is to be made with another portion of the Swedish triangulation. The two base lines already mentioned are situated at the extremities of this chain of triangles, one at Egeberg, near Christiana, and the other at Rindenleret, near Levanger; both were measured during the summer of 1864, and Part I. is the report of these measurements.

The base measuring apparatus used is similar to that employed by Struve for the measurement of several base lines in Russia; it belongs to the Swedish Government, and was used for the measurement of their base lines. The apparatus consists of four cast-iron tubes, each approximately 2 toises[2] in length. One end of each tube is fitted with a small highly polished steel stud, and the other end with a "contact lever." The short arm of the contact lever terminates in a steel stud, which is intended to press against the fixed stud of the adjoining tube; the long arm moves on a scale. A measuring rod capable of varying its length to a slight extent is thus obtained, and this alteration in length can be measured with great delicacy, since the long arm of the lever greatly exaggerates it. This arrangement insures that the pressure between the rods is constant. Each tube is provided with two thermometers, the bulbs of which are bent nearly at right angles to the stem, and are inserted into small holes in the tubes. In order to protect the tubes as far as possible from changes of temperature they are wrapped round with several thicknesses of cloth, and are further inclosed in a wooden box, out of which the two ends of the tube just project. During the measurement of a base line each rod is supported on two trestles, at one-fourth and three-fourths of its length, provided with screw arrangements giving slow motions laterally and in elevation. The rods are not, however, accurately levelled, and a correction has to be made for dislevelment. To measure the small angle of inclination each rod is fitted with a very sensitive level. One end of the level works on trunnions, the other is connected to a micrometer screw by means of which the level can be raised or lowered. The bed of the level is attached to the top of the box, but in such a manner that it can be adjusted truly parallel to the tube. The value of each micrometer division was determined by means of the meridian circle in the observatory at Christiana. It will be seen from the above that, as the measurement of a base line proceeds, the following readings are required for each rod: (1) the contact lever; (2) the thermometers; (3) the micrometer for inclination. These readings were taken and booked independently by two observers. Both base lines were measured twice, once in each direction.

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[1] Publications of the Norwegian Committee of the European Association for the Measurement of Degrees. Geodetical Operations. Published in Three Parts. (Christiania, 1880 and 1882.)

[2] A toise is 2·13151116 yards as determined by Col. A. R. Clarke, C.B., R.E., F.R.S., &c.

Before and after the measurement of each base line each rod was compared with a *standard* rod, the exact length of which was known, namely:

$$= 1727{\cdot}96641\,(1 + 0{\cdot}000011476\,(t - 16^\circ{\cdot}25)) \pm 0.00058$$

expressed in Paris lines[1] based on Bessel's toise, t being expressed in degrees Centigrade. It was found that the rods were slightly diminished in length during the measurement of a base line (on an average 0·005 lines) owing to abrasion. An allowance was made for this diminution in length. The apparatus with which these comparisons were made consists of a massive cast-iron beam, turned up at both ends, and carrying two supports fitted with rollers upon which the rod to be measured rests. One end of this beam is fitted with a fixed steel stud, against which the contact lever of the rod under comparison bears; the other end carries a sliding scale, connected with a contact lever, and read by means of a micrometer microscope. A set of readings consisted in first measuring the standard rod, then each of the four measuring rods in succession, and lastly the standard rod again; the temperature of each rod was carefully noted. For a complete comparison twelve such sets of readings were taken.

The time occupied in measuring the Egeberg base was 18 days, and the observations for each measuring rod occupied 4 minutes; the Rindenleret base was measured more rapidly, namely, 2½ minutes per rod, due to the site being more level.

A considerable portion of Part I. is taken up in considering the errors to which the measurements of these base lines are liable, in estimating the allowances to be made to correct these errors, and in computing the probable errors of the final results. These errors are due: (1) to errors of observation in the actual measurement of the base lines; (2) to the error in the adopted length of the measuring rods.

Firstly, the errors to which the actual measurement of a base line is liable are as follows:—

A slight uncertainty attaches to the micrometer readings of the levels measuring the inclination of the rods. The probable error is computed to be

Egeberg base	± 0·350 lines
Rindenleret base	± 0·183 ,,

The errors due to the contact levers are next considered. It is shown that the error caused by the small uncertainty in the value of a degree of the scale over which the long arm of the lever moves, is too small to be taken into account, but the error caused by uncertainties in reading the scale is of sensible amount, and is computed to be

Egeberg base	± 0·015 lines
Rindenleret base	± 0·014 ,,

Further, the surface of the steel studs, at the end of the rods, is a portion of a sphere whose radius is considerably less than the length of a rod. Hence an error will occur each time a contact lever does not touch at the centre of the stud, that is if it makes an eccentric contact, and although every care was taken to obtain accurate contacts, it is considered that a correction of the following amounts should be made—

Egeberg base	− 0·351 ± 0·175 lines
Rindenleret base... ...	− 0·314 ± 0·157 ,,

The next source of error is that due to errors in alignment, these errors will always be negative, and are due to the uncertainty in placing the rods in the line given by the directing theodolite. This error is computed to amount to

Egeberg base	− 0·294 ± 0·101 lines
Rindenleret base... ...	− 0·262 ± 0·090 ,,

The computed variation of length of the rods due to alterations in temperature is vitiated by several errors. In the first place, the coefficient of expansion of the rods, as determined by Prof. Lindhagen, is affected by the small uncertainty, 0·000000015. Further, the correction for expansion is computed on the supposition that the thermometers do actually indicate the mean temperature of the rods at the time of taking the readings; but this is an assumption, and in fact it is estimated that the temperature indicated by the thermometers is the temperature the rod had 20·0 ± 5·9 minutes before taking the reading. This estimate is arrived at as follows: It will be remembered that each base line was measured twice; the difference between the two measurements is due to the various errors under consideration, and its probable value can therefore be computed; this computed value will contain, as an unknown, the time of which an estimate is required. Hence, by equating the computed difference to the actual difference the time can be found. The total error in the allowance made for expansion is found to be

Egeberg base...	$\pm 0{\cdot}085 + 0{\cdot}525\,\Lambda$
Rindenleret base	$\pm 0{\cdot}071 + 0{\cdot}250\,\Lambda$

where $\Lambda = 20{\cdot}0 \pm 5{\cdot}9$ minutes.

Secondly, the errors due to the uncertainty in the accepted length of the rods are considered under four heads, namely: (1) the error in the length of the standard rod; (2) the error due to the bending of the beam of the comparing apparatus (some experiments were made to obtain data for the calculation of this error); (3) the error in comparing the rods with the standard; (4) the error due to the assumption that the diminution in length of the rods by abrasion is proportional to the length of time in use. The probable error of the accepted length of a rod during the measurement of the Egeberg base is computed to be ± 0·00081 lines, and during the measurement of the Rindenleret base ± 0·00071 lines.

Finally, the base lines had to be reduced to the sea-level; data had been obtained for this purpose by means of spirit-levelling operations. The reduction in the length of the base lines due to this cause is

Egeberg base	− 33·89 lines
Rindenleret base	− 0·852 ,,

Applying all these various corrections to the measured lengths of the base lines the final results are as follows:

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[1] A Paris line is defined by 1 Paris line = $\frac{1}{864}$ toise, hence 1 Paris line = 0·088813 English inch.

Egeberg base ... ... 2025·28316 toises,

with a probable error of ± 0·00129, or $\frac{1}{1{,}570{,}000}$ of its length.

Rindenleret base ... ... 1806·3177 toises,

with a probable error of ± 0·00120, or $\frac{1}{1{,}500{,}000}$ of its length.

This is a high degree of accuracy as compared with older base lines (as for instance several base lines measured in France between 1798 and 1828, of which the probable errors are $\frac{1}{250{,}000}$) ; but this accuracy has frequently been attained of late years, and even surpassed, as, for instance, the base line of Madridejos, measured by General Ibañez in 1858, with a probable error of $\frac{1}{5{,}865{,}800}$.

Part II is the account of the connection of the Egeberg base with the side Toass-Kolsaas, and Part III. that of the connection of the Rindenleret base with the side Stokvola-Haarskallen of the principal triangulation. The observations were made during 1864-66, but owing to an error at one of the stations, due to the bisection of a wrong object, further observations were made at that station in 1877. The connection in each case is very complete, and the work is well tied in. The centres of the trigonometrical stations were very carefully defined by letting an iron bolt into the rock, or, into a large block of stone; the centre of the face of this bolt, marked by a small hole, was the trigonometrical station. The signals, to which the observations were taken, consisted of an upright beam, to which was attached one or two boards about 0·75 m. square, which were painted white or black, and occasionally a vertical stripe 0·11 m. broad was painted on the centre of the board. At several of the stations the theodolite could be placed beneath the signal, and at such stations the signal was placed over the bolt, but in several cases, owing to the nature of the ground, or other causes, the trigonometrical station had to be placed at some distance from the signal, in one case as much as 54 Norwegian feet. In such cases the corrections to be applied to the observations were obtained by measuring a short base line, one end of which was the trigonometrical station, and the direction nearly at right angles to the line joining the station and the signal. Observations were taken from the ends of this base to the various points on the signal, which were bisected from the other stations, and these, together with the observed bearings to and from the other stations, enabled the necessary corrections to be made. The greatest correction thus required was 10′ 37″·34. But even at stations where the theodolite was placed beneath the signal, corrections were required to reduce the observations to the trigonometrical station, because different points on the signal were observed from the other stations, and these points were not vertically over the bolt. In these cases the corrections were computed in the following manner:—A piece of paper, mounted on a board, was placed horizontally on the ground over the centre of the station, and this centre marked on it. Then, by means of a small theodolite, the "traces" of the vertical planes passing through the various points observed to, were marked in pencil on the paper. The theodolite was now shifted, and the corresponding traces marked as before; the intersections of these traces gave a series of points vertically beneath the points on the signal to which observations had been made. From these points, the corresponding bearings to the various stations were plotted on the paper; and, lastly, perpendiculars were dropped, from the point representing the centre of the station, on to these bearings; the length of any one of these perpendiculars divided by the approximate distance to the corresponding station is the tangent of the correction to be applied.

Two instruments were used for measuring the angles; a 10″ universal instrument by Olsen, read by two micrometer microscopes, and a 12″ theodolite by Reichenback, read by four verniers. The errors of graduation of these instruments were investigated, and are given in a tabular form in Part II. Although, owing to the numerous observations taken to each object starting from different parts of the horizontal limb, the errors of graduation must have been eliminated to a very large extent, yet it was thought advisable to apply these corrections to the observations, in order to obtain a more accurate idea of the bearings of each station. The errors of the micrometer microscopes are also given in a table. The 10″ instrument was used at all, the 12″ theodolite appears to have only been used at two, stations. A third instrument, a 10″ universal instrument by Breithaupt and Sons, was used for the observations of 1877.

When observing, the instrument was first set at 0°, and a round of angles taken: the telescope was then reversed and the round taken again. The instrument was then set at 15° in the case of the triangulation connecting the Egeberg base, and at 20° (nearly) in the case of the Rindenleret base triangulation, and two rounds taken as before. The instrument was then again moved on 15° and 20° respectively, and so on. Thus in the first case forty-eight, and in the second thirty-six observations were taken to each station. In some few instances even a greater number were taken. The actual observations are not given in the Report, only the mean of four observations—two taken in the same position of the horizontal limb, and two in that position increased by 180°. The time occupied at each station averages four days; some stations were completed in two days.

The observations were compensated by the method enjoined by the Association for the measurement of degrees in Europe, namely, Bessel's method. The observed angles at each station are first compensated amongst themselves. A correction is then applied to each angle thus found, subject to the condition that the sum of the squares of these corrections for the whole triangulation is a minimum, and subject further to the geometrical conditions that the sum of the three angles of a triangle = 180 + spherical excess, and that the length of any side is the same by whatever *route* it is calculated. The necessary calculations are very laborious, and in the case of the Rindenleret base require the solution of simultaneous equations containing seventy-six unknowns. It is very questionable whether the result repays this labour; the method of compensation adopted for the Ordnance Survey, although perhaps not so rigid, compares favourably in this respect. The calculations for compensation are given very fully in the Report.

The Report is accompanied by plates showing the base measuring apparatus and the connecting triangulations.

ELEMENTS OF THE GREAT COMET OF 1882

(*Communicated by Vice-Admiral Rowan, Superintendent U.S. Naval Observatory*)

THE following elements were computed from three observations made at the U.S. Naval Observatory; the first and last being made with the Transit Circle, and the middle one compared with a known star which was afterwards observed on the Transit Circle:—

Wash. M.T.			App. α.				App. δ.		
			h.	m.	s.		°	′	″
Sept.	19·9697877	...	11	14	18·94	...	− 0	34	29·7
Oct.	8·7204363	...	10	28	6·63	...	− 10	40	22·6
Nov.	4·7009228	...	9	6	16·22	...	− 27	21	26·7

From these observations we deduce—